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(54) Printer and method of controlling it.

(57) A serial printer has a pulse generator (25, 25a, 31) for generating timing pulses in a number proportional to the movement of a carriage mounting the printer's recording head. The pulse generator comprises an encoder (25) and a detector (31) moved relative to each other as the carriage is moved. The detector is responsive to marks (25a) provided on the encoder (25) for generating the timing pulses. Blocking means (33) are provided to block the detector (31) when the carriage is at a predetermined position such that the detector cannot detects any marks of the encoder as long as the blocking condition is maintained. Signal processing means are provided to recognize the blocked condition of the detector and to output a home position detection signal in response to it. In this way the pulse generator also functions as a home position detector obviating use of a separate home position detector.

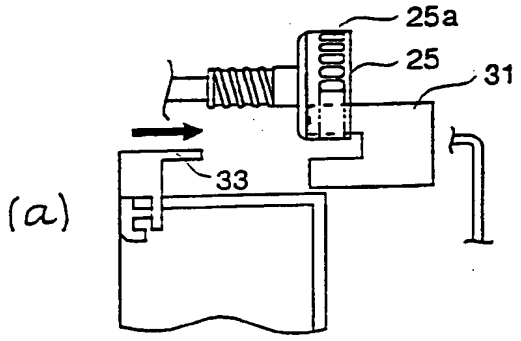

FIG. 6

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This invention relates to a serial printer and, more particularly, it relates to means for detecting a home position of the recording head of a serial printer. The invention also pertains to a method of controlling the printer.

US-A-4,920,258 discloses a serial printer which comprises a recording head, a carriage on which the recording head is mounted, a motor that drives th carriage, a dot pulse generator composed of a slotted disc as a rotary encoder attached to the motor axis as well as a first photo interrupter, and a home position detector composed of a second photo interrupter for detecting a shield plate attached to the carriage. In this prior art, dot or timing pulses put out by the first photo interrupter are required and used to detect the relative print position (dot-to-dot distance) of the recording head during the printing operation. The output of the second photo interrupter, i.e., the home position detector is needed to detect the home position (the reference start-of-print position) for determining the recording head's absolute print position. Thus, this prior art requires at least two separate detectors for its operation.

JP-A-77514/1993 discloses a serial printer similar to the one explained above. In this prior art, however, a single detecting means is used for generating timing pulses on the one hand and for detecting the home position of the carriage on the other hand. The detecting means comprises a scale plate arranged to extend parallel to the direction of the reciprocating movement of the carriage. The length of the scale plate substantially corresponds to the length of stroke of the carriage. The scale plate has transmissive portions regularly spaced by opaque portions along the length of the plate. No transmissive portions are provided in the scale plate at a position corresponding to the home position of the carriage. A photo interrupter is mounted to the carriage to engage with the scale plate and to generate timing pulses as the carriage moves along the scale plate. From the fact that no timing pulses are generated for a certain period of time longer than the normal interval between two successive timing pulses, a CPU detects that the carriage is at its home position.

While the prior art of JP-A-77514/1993 needs only a single detector it has several disadvantages such as the following. If a scale plate, i.e. a linear encoder of reasonable costs is employed, the resolution that may be achieved, i.e. the number of timing pulses per unit travel distance of the carriage, is far less than that possible with a simple rotary encoder. Normally, the printer is driven by a motor of a certain rotational speed. The drive power of the motor is transferred to the carriage via speed reducing gears. Since a rotary encoder can be coupled to nearly any member of the drive mechanism between the motor and the carriage it can be rotated at a much higher speed than the carriage itself. Thus, the relative speed between a rotary encoder and its associated detector can be much higher than that between the linear encoder and the photo interrupter according to the prior art of JP-A-77514/1993. Furthermore, in case of a linear encoder, its length must match the stroke length of the carriage. Thus, for printers of different widths, individually adapted linear encoders or scale plates must be provided.

The object of the present invention is to overcome the drawbacks of the prior art explained above and to provide a reasonably priced serial printer capable of detecting, with high accuracy and by means of a single detector, the home position of the carriage on which the recording head is mounted and the relative position of the carriage during a printing operation.

This object is achieved with a serial printer as claimed in claim 1 and a method of controlling it as claimed in claims 4 and 5, respectively.

Preferred embodiments of the invention are subject-matter of the dependent claims.

The printer according to the present invention has a pulse generator for generating timing pulses in response to the reciprocating movement of the carriage carrying the recording head. The pulse generator comprises rotary encoder and a fixed detector for detecting physically distinct marks provided in or on the encoder, as these marks move past the detector in response to the rotation of the encoder. In one embodiment of the invention the pulse generator may be comprised of a rotary encoder and an associated photo interrupter similar to those of the prior art referred to above. In such case the marks to be detected are light transmissive or light reflective portions regularly spaced by opaque or non-reflective portions. However, magnetic detectors, capacitive detectors and others may be employed instead. As will be understood by those of ordinary skill in the art, in each case the detector will output pulses in a number proportional to the rotation of the encoder and, hence, proportional to the movement of the carriage.

While generally various types of a known rotary encoding pulse generator may be employed for the purpose of the present invention, a characteristic feature of the invention resides in the fact that blocking means are provided to block the detector, i.e., prevent it from responding to the marks provided in or on the encoder, when the carriage is at a predetermined position, preferably its home position. The blocking means are moved in association with the movement of the carriage. The pulse generator and the blocking means are arranged in such manner that, assuming a continuous reciprocation of the carriage, the detector is blocked, for

a period appreciably longer than the interval between two successive pulses from the unblocked detector. In other words, the pulse generator is made to output timing pulses with a certain pulse interval as long as the detector is unblocked and at least two timing pulses with a substantially longer pulse interval each time the detector is blocked when the carriage runs past the predetermined position. Signal processing means are provided for detecting the longer pulse interval thereby to detect the home position of the carriage. The blocking means may be mounted to the carriage, the recording head, or any other means in the drive chain transferring drive power from the motor to the carriage as long as it can be made to engage and thereby block the detector if and only if the carriage is at or immediately next to its home position. In this way the function of the timing pulse generator using a rotary encoder known per se, is extended and a single detector can be used to detect both, the absolute position as well as the relative position of the carriage. Thus, the high resolution of timing pulses and the independence of the pulse generator from the length of stroke of the carriage that are possible with a rotary encoder can be combined with a highly accurate home position detection with a single same detector.

Further, according to the control method of the present invention, when the carriage is to be stopped at its home position, a predetermined number of timing pulses is counted starting from the detection of a longer pulse interval and, when the number has been counted, the motor is deenergized. The predetermined number to be counted is selected such when the motor is deenergized while the carriage is on its way to the home position, the carriage will be continued to be moved by the inertia of the system and stop just when reaching its home position. In this way any overshooting of the home position by the carriage due to inertia is avoided, and the carriage can be stopped accurately at the desired position.

The invention will be described in detail below with reference to the drawings which illustrate a preferred embodiment only and in which:

- Fig. 1 is a partly exploded perspective view, seen from the front side, of an inkjet printer embodying the present invention,
- Fig. 2 is a perspective view, seen from the rear side, of the inkjet printer,
- Fig. 3 is a cross-sectional view of the inkjet printer,
- Fig. 4 is a plan view of the inkjet printer,
- Fig. 5 is a block diagram showing the circuit configuration of a desktop electronic calculator that incorporates the inkjet printer of Fig. 1 and a drive control device,
- Fig. 6 are diagrams for explaining the mechanism for detecting the carriage home position,
- Fig. 7 is a flowchart depicting the operation by which the carriage is positioned at the home position when the power is turned on,
- Fig. 8 is a timing chart for timing pulses of the embodiment in Fig. 5, and
- Fig. 9 is a flowchart depicting the printing operation in the embodiment of Fig. 5.

The basic structure of a first embodiment of the invention will first be explained with reference to Figs. 1 to 4.

As shown in Fig. 1, the inkjet printer is composed of printer unit 10 and paper feed unit 50. Fig. 1 shows the paper feed unit 50 detached from the printer unit 10. Printer unit 10 comprises a frame 13. Frame 13 has a base plate 131, two side plates 132 and a front plate 133.

The side plates 132 and the front plate 133 are bent at right angles from the base plate 131. Two guide rods 14 are mounted to the side plates 132 to extend in parallel to each other and to the front plate 133. A carriage 12 is slidably supported on the guide rods 14 for a reciprocating movement between the two side plates 132. An inkjet cartridge 11 is mounted on the carriage. The inkjet cartridge 11 includes an inkjet head 11a and an ink container (not shown). Nozzles of the inkjet head 11a, indicated by dots in Fig. 1, face the front side of the printer unit, i.e. towards front plate 133. Carriage 12 is coupled to a endless timing belt 19 stretched between a driving gear 18 and a driven gear 20 to extend in parallel to the guide rods 14. Timing belt 19 is arranged at the rear side of the carriage 12. Gear 18 is fixed to one end of a shaft 17a while gear 20 is fixed to one end of a shaft 17b. Shafts 17a and 17b are supported each at the other end by a respective flange portion 134, 135 of the frame. A drive motor 15 is disposed behind timing belt 19. A worm gear 15a (see Fig. 3) is fixed on the motor shaft. Worm gear 15a is engaged by a worm wheel 16 fixed to shaft 17a. Thus, drive of the motor 15 is transmitted via worm gear 15a, worm wheel 16, shaft 17a and gear 18 to the timing belt 19.

In the present embodiment drive motor 15 is a DC motor, whose shaft, when driven, always rotates in the same direction. Thus, the timing belt is also driven always in the same direction. In order to have the carriage reciprocating between the side plates 132 of the frame in response to such drive of the timing belt, a drive pin 30, shown in Fig. 3, is fixed to the timing belt 19 and alternately couples the carriage 12 with the upper and the lower run of timing belt 19. Since this is a well known mecha-

nism a further detailed description will be omitted. Incidentally, cable 26 shown in the figures is for connecting the drive motor 15 and a sensor 31 explained later to a control circuit not shown. Likewise, cable 27 is for connecting the inkjet head 11a to the control circuit.

In this way, the drive power of drive motor 15 is used to reciprocate the carriage 12 and the inkjet cartridge along guide rods 14. The drive power of the motor is also used for driving a paper feed mechanism of the paper feed unit 50. This is achieved by means of a transmission shaft 23 best shown in Figs. 1 and 4. A gear 22 is fixed to one end of the transmission shaft 23 and a worm gear 24 to the other end. Transmission shaft 23 is supported in the frame 13 so that gear 22 is engaged with an intermediate gear 21 fixed to shaft 17b. In this way, transmission shaft 23 is driven in response to a movement of the timing belt 19.

Paper feed unit 50 is provided with a gear train 51. When the paper feed unit is mounted to the printer unit, the gear train 51 is engaged with worm gear 24. As shown in Fig. 3, paper feed unit 50 includes two feed rollers 52 and 53. Feed rollers 52, 53 are disposed in a feed path at an intermediate position between a paper inlet slit 56a and a paper outlet slit 56b and are arranged to be driven in mutually opposite directions by means of the gear train 51. With paper feed unit 50 mounted to the printer unit 10 printing is performed on print media fed by paper feed unit 50 through the feed path bent as shown in Fig. 3. With a serial printer like the present one, the print medium is fed by a distance corresponding to the line spacing each time one line has been printed and prior to the start of the next line. Since the worm gear is continuously rotated as the carriage is moved, the gear train 51 has to convert this continuous drive into an intermittent drive of the feed rollers 52, 53. In the present embodiment, printing is performed while the carriage is moved from a home position at one end of its range of movement to the other end. During this forward stroke of the carriage drive power is not transferred to the feed rollers. During the following backward stroke gear train 51 couples the drive rollers to the worm gear causing the print medium to be fed. Thus, gear train 51 functions as an intermittent or indexing drive mechanism.

According to the present invention paper feed unit 50 is mounted to the printer unit to be easily detachable. In this embodiment it is screwed onto front plate 133 of the frame 13. By configuring the printer unit 10 in the way described above, when the paper feed unit 50 is detached, the nozzles of inkjet head 11a are at the very front of the printer unit with nothing protruding forward beyond the plane of the nozzles (except for the front plate 133 in the embodiment). This enables rigid print media to be brought sufficiently near to the inkjet head 11a without necessity for bending. As will be explained in more detail later, in the preferred embodiment of the invention, front plate 133 is arranged in a manner so that its front side may be used as a guide surface 13a for such rigid print media like slip paper that cannot be fed through the curved feed path of paper feed unit 50.

Printer unit 10 is provided with a rotary encoder 25 that detects the rotation of motor 15. The encoder is fixed on the motor shaft in front of worm gear 15a as shown in Fig. 4. Encoder 25 is a cup-shaped member with a circumferential wall in which a plurality holes 25a are provided with regular intervals in the circumferential direction. This wall is received in the opening of a C-shaped sensor 31 of a so-called photo-interrupter type. As encoder 25 rotates, holes 25a allow the passage of the light emitted from one end of sensor 31 so that the other end of sensor 31 can pick up the light. In this way sensor 31 generates timing pulses and detects the rotation of motor 15. As will be appreciated by those of ordinary skill in the art, a signal representing the position of the carriage is derived from the timing pulses in the control circuit not shown.

Figure 6 depicts a mechanism for detecting the home position of carriage 12. A shield plate 33 is attached to carriage 12. When carriage 12 reaches the home position, shield plate 33 blocks the light path of sensor 31. Because the length of time during which the light path is blocked by shield plate 33 is greater than the length of time during which light is blocked between two successive holes 25a of rotary encoder 25, it is possible to detect the home position by measuring the time during which no timing pulse is output by the sensor 31. In Fig. 6, (a) shows the carriage in a position just before reaching its home position, (b) shows the carriage in its home position with shield plate 33 intercepting the light, and (c) shows the carriage in a position when it has just left its home position.

In the inkjet printer composed as described above, control voltages for motor 15 and sensor 31 are supplied through cable 26. Likewise, control signals are supplied through cable 27 to inkjet head 11a. The rotational drive of motor 15 rotates timing belt 19 which in turn reciprocates carriage 12 as has been described. During the forward stroke of the carriage ink is ejected from inkjet head 11a according to the control signals and printing is performed. When printing of one line has been completed and the carriage is returned to its home position, the paper-feed rollers 52 and 53 are driven to advance the print medium by one line. These operations are performed repeatedly for each line that is printed.

Although the embodiment of the printer unit described above contains a drive mechanism at the back of inkjet head 11a, the drive mechanism can also be provided below the head 11a in order to enable slip printing in the same manner as described. Further, although the embodiments show the case where paper feed unit 50 is secured to printer unit 10 with screws, the present invention is by no means limited to this method of securing. Other means, such as permanent magnets, can be employed as long as the means allows easy detachment of the paper feed unit.

Fig. 5 is a block diagram of a desktop electronic calculator (hereinafter "DEC") incorporating a printer as described above. In Fig. 5 only the electrical components of the printer unit 10 are shown together with a control device of the DEC that controls the printer. The DEC is provided with CPU 201, which controls the entire DEC, ROM 202, RAM 203, timer 204, display unit 205, and keyboard 206. CPU 201 is connected to the components of printer unit 10 through its I/O port. Head drive circuit 208 is connected to recording head 11a. Motor drive circuit 207 is connected to motor 15. Sensor 31, which outputs the timing signals and detects the position of recording head 11a, is connected to CPU 201 through detection circuit 209. As will be understood, in the embodiment of the printer explained above, the encoder 25 and the sensor 31 (as detector) form the pulse generator of the present invention.

Fig. 7 shows a flowchart depicting the operation (initialization) that positions the carriage 12 with the inkjet head 11a mounted on it, at the home position when the power is turned on. First, the power for motor 15 is turned on in order to start the motor (S1). CPU 201 reads a detection signal from sensor 31, i.e., a timing pulse, through detection circuit 209 and waits until the timing pulse (TP) changes from L (low-level signal) to H (high-level signal) (S2). When the timing pulse has changed L->H, the CPU starts time measurement by timer 204 (S3). After that, the CPU waits again until the timing pulse changes again L->H (S4). When the timing pulse has become H, the CPU stops the measurement by timer 204 (S5). Thus, a pulse cycle of the timing pulses is obtained by executing steps (S2) to (S5). Then, the CPU determines whether or not the pulse cycle measured by timer 204 is greater than or equal to 10 msec (S6). If the measured value is smaller than 10 msec, the CPU assumes that normal timing pulses are being measured, resets timer 204(S7), and returns to step (S3).

Fig. 8 is a timing chart for timing pulses. In this embodiment the timing pulse cycle is assumed to be 0.25 msec, for example, and the time interval during which shi ld plate 33 masks or blocks sensor 31 in the course of a movement through (a) -> (b) -> (c) in Fig. 6, is assumed to be 25 msec, for example. In the following, "normal area" or "non-masked area" refers to positions of the carriage where the shield plate is not inserted in sensor 31, i.e. positions other than that indicated in Fig. 6(b). On the other hand "masked-area" refers to the position (or range of positions) where the shield plate masks the light receiver part of sensor 31. In step (S5), when the measurement is performed in the normal area the measurement time after which timer 204 is stopped is 0.25 msec, so that control returns to the processing at step (S3). On the other hand, in the masked area the measurement time after which timer 204 is stopped at step (S5) is 25 msec, i.e., a value greater than or equal to 10 msec. When the end of the masked area is detected in this manner, the CPU begins to count timing pulses (S8). If the end of the masked area is on the left side of the printer, for example, carriage 12 advances toward the right and reaches the right edge, from which it advances again toward the left. When the carriage approaches the left edge and the count reaches a value such as "850" (assuming that there are "916" timing pulses per round-trip of the carriage) (S9), the drive power for motor 15 is turned off at that timing (S10).

This causes motor 15 to stop after having continued to rotate for a fixed rotational angle (e.g., corresponding to "66" timing pulses) by inertia. By appropriately setting the value assumed to be 850 in this example the motor can be made to stop just when the carriage is at a position coincident with the home position. In step (S6) when the time measured by timer 204 is greater than or equal to 10 msec, carriage 12 is at the home position (or at least very near to it, depending on what position is exactly defined to be the home position). However, if the drive power to the motor 15 were turned off at that time, due to the inertia of the system, the carriage would not stop at the home position. Therefore, using this timing as a starting point, carriage 12 is allowed to make one round trip, and the drive power for motor 15 is turned off at a predetermined time, equivalent to the distance over which the carriage moves due to inertia, prior to the time when the carriage reaches the home position. In this way, carriage 12 is made to stop at the home position. After the drive power for motor 15 is turned off, the timing pulse count value is reset (S11).

Fig. 9 is a flowchart depicting the printing operation. It will be assumed that at the start of this printing operation the carriage is at rest at its home position as result of the initialization explained above. Thus, first, the carriage is started in its motion by turning on the driv power for motor 15 (S21), and CPU 201 begins the count timing pulses

(S22). During this operation motor 15 is accelerated, and when the pulse count reaches a prescribed value, of let us assume 40 as an example (S23), the motor shifts from the acceleration area to the constant-speed area and printing is performed (S24). In this operation the printing is performed as carriage 12 moves from the left edge to the right edge. If, for example, a line comprises 19 columns each of a character width of 9 dots, and 1 dot corresponds to 2 timing pulses, this amounts to 19 columns × 9 dots/character × 2 = 342. Thus, the number of pulses that are generated per line of printing is 40 + 342 = 382 pulses. Upon reaching the right edge, carriage 12 automatically begins to move to the left, at which time paper feed unit 50 advances the recording paper by one line. When the number of timing pulses reaches "850" (S25), the CPU determines whether or not the printing is to be continued (S25) (i.e. whether or not recording data remains in RAM 203). If the printing operation has been completed, the CPU turns off the drive power for motor 15 (S27). This causes motor 15 to continue rotation for a fixed length of time by inertia, and then to stop just at the home position as in the case of the initialization described above.

If the printing operation is to be continued, the CPU waits until the timing pulse from sensor 31 changes L->H, as in the case of the initialization described above (S28). When the timing pulse has changed L->H, the CPU starts the time measurement by timer 204 (S29). After that, the CPU waits until the timing pulse changes again L->H (S30).

When the timing pulse has become H, the CPU stops the measurement by timer 204 (S31). Then, the CPU determines whether or not the value measured by timer 204 is greater than or equal to 10 msec (S32). If the measured value is not greater than or equal to 10 msec, the CPU assumes that the carriage is still in the unmasked area, resets timer 204 (S32a), and returns to step (S29). When the value measured by timer 204 becomes greater than or equal to 10 msec (S32), the current position is at the end of the masked area, i.e., the home position. In this case, the CPU resets the timing pulse count (S33), returns to step (S22), and prints another line. The above operations are repeated until the printing is completed (S26).

Although this embodiment has been described to have an inkjet head as a recording head, the present invention is by no means limited to the use of inkjet heads; it can be applied to serial printers using a wire dot head or a thermal head, or a character head in the same way.

Claims

1. A printer comprising,
   a carriage (12),
   a recording head (11a) mounted on the carriage (12)
   a drive mechanism (15, 16, 18, 20) for reciprocating said carriage,
   a pulse generator (25, 31) comprising a rotary encoder and a fixed detector adapted to output timing pulses in response to a movement of a member (15) of the drive mechanism,
   and home position detection means (25, 31, 201-204, 209) for detecting a home position of the carriage (12),
   characterized by,
   movable blocking means (33) arranged to be engaged with and disengaged from the pulse generator, the blocking means engaging the pulse generator while the carriage is in a predetermined position, to prevent the pulse generator from responding to a movement of said member(15), and
   signal processing means (201-204, 209) responsive to the said timing pulses and adapted to detect the blocked condition of the pulse generator and to generate a home position detection signal when it detects the blocked condition.

2. The printer of claim 1, wherein
   the rotary encoder (25) has at least one mark (25a) and the detector (31) is arranged to detect said mark as it passes due to the rotation of the encoder and to put out a timing pulse each time it detects the mark, and
   the blocking means (33) comprises a shield member arranged to intercept a path between the encoder and the detector such as to disable the detector from detecting the mark.

3. The printer of claim 1 wherein
   the rotary encoder (25) comprises regularly spaced marks (25a) arranged in the circumferential direction and is mounted on said drive mechanism to rotate as the carriage (12) moves, while the detector (31) is provided in proximity to the encoder for generating said timing pulses by detecting the marks on the encoder,
   the blocking means (33) comprises a shield plate which is attached to said carriage (12) and which intercepts the path between the encoder and the detector at a home position of the carriage such as to disable the detector from detecting the marks, and
   the signal processing means (201-204, 209) comprises means for receiving the timing pulses from the detector and for detecting the home position based on the intervals between

successive timing pulses.

4. A method of controlling a printer as defined in any one of the preceding claims, comprising the steps of:
(a) energizing the drive mechanism in response to the power being turned on,
(b) measuring the time of either the cycle of or the interval between each pair of successive timing pulses while moving the carriage in the direction toward its home position,
(c) starting to count the number of said timing pulses when said measured time assumes a value greater than or equal to a predefined reference time, and
(d) deenergizing said drive mechanism when a predetermined number of timing pulses has been counted.

5. A method of controlling a printer as defined in any one of claims 1 to 3, comprising the steps of:
(e) energizing the drive mechanism with the carriage being in its home position,
(f) counting the timing pulses while moving the carriage in a first direction away from its home position,
(g) printing one line according to recording data after the carriage has reached a print area while still moving it in said first direction,
(h) moving the carriage in a second direction opposite to said first direction, and
(i) when no further line is to be printed, deenergizing said drive mechanism when the count value of said timing pulses reaches a predefined reference count value, while
(j) when a further line is to be printed, measuring the time of a either the cycle of or the interval between each pair of successive timing pulses while moving the carriage in the direction toward its home position,
(k) resetting the pulse count when said measured time assumes a value greater than or equal to a predefined reference time, and re-starting to count the timing pulses while moving the carriage in said first direction, and
(l) returning to step (g).

6. The method of claim 5 additionally including the steps of claim 4.

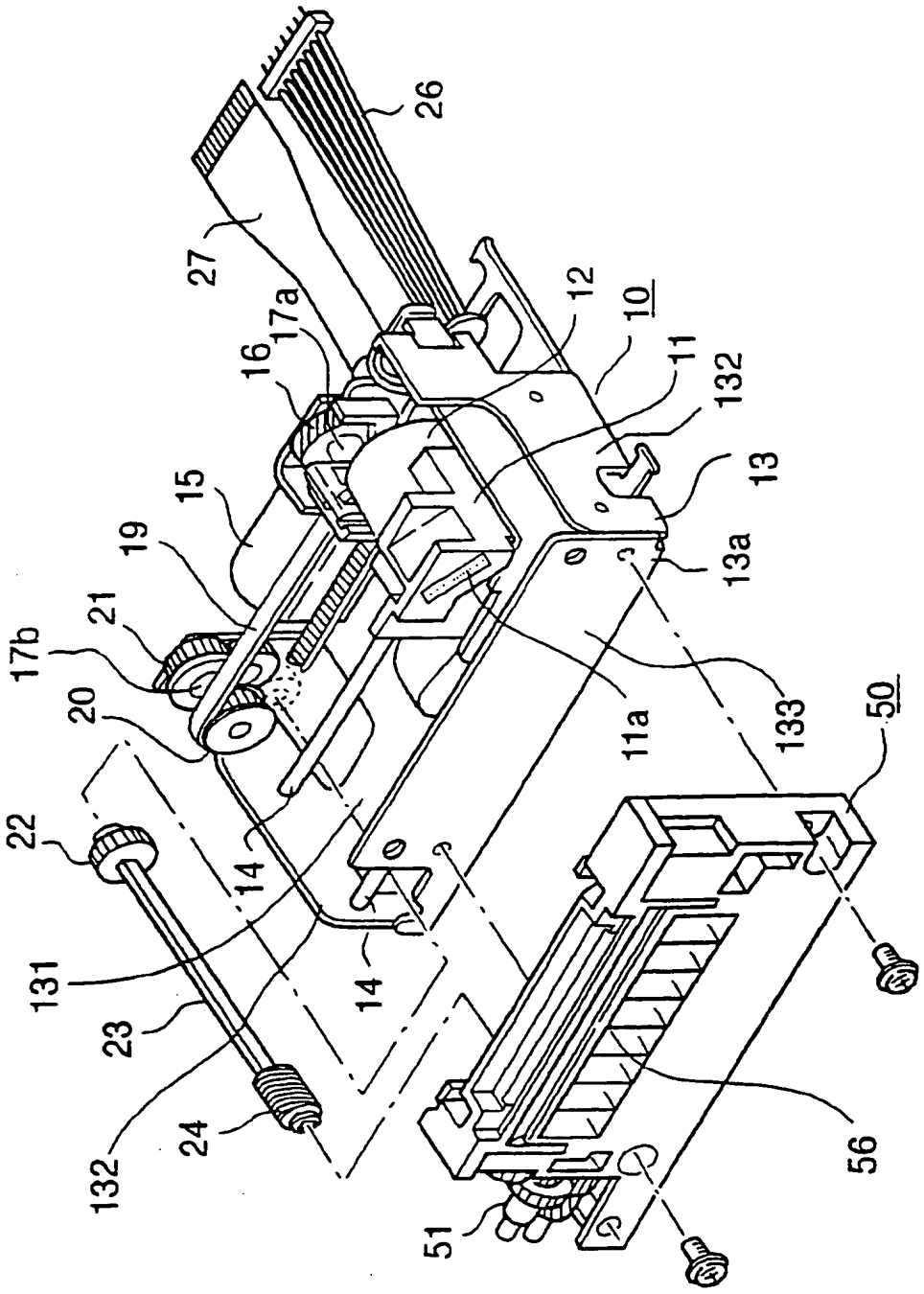
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FIG. 1

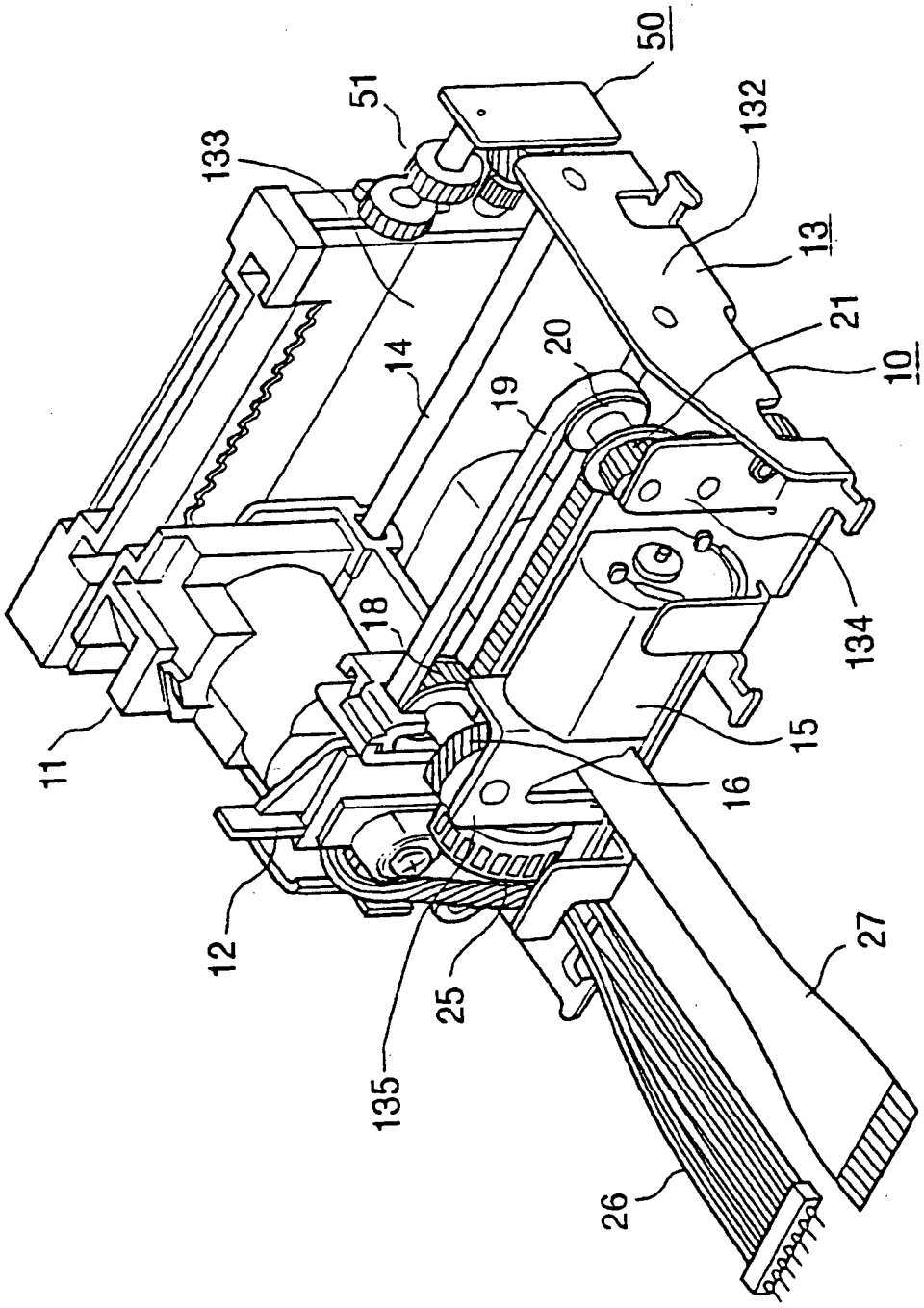


FIG. 2

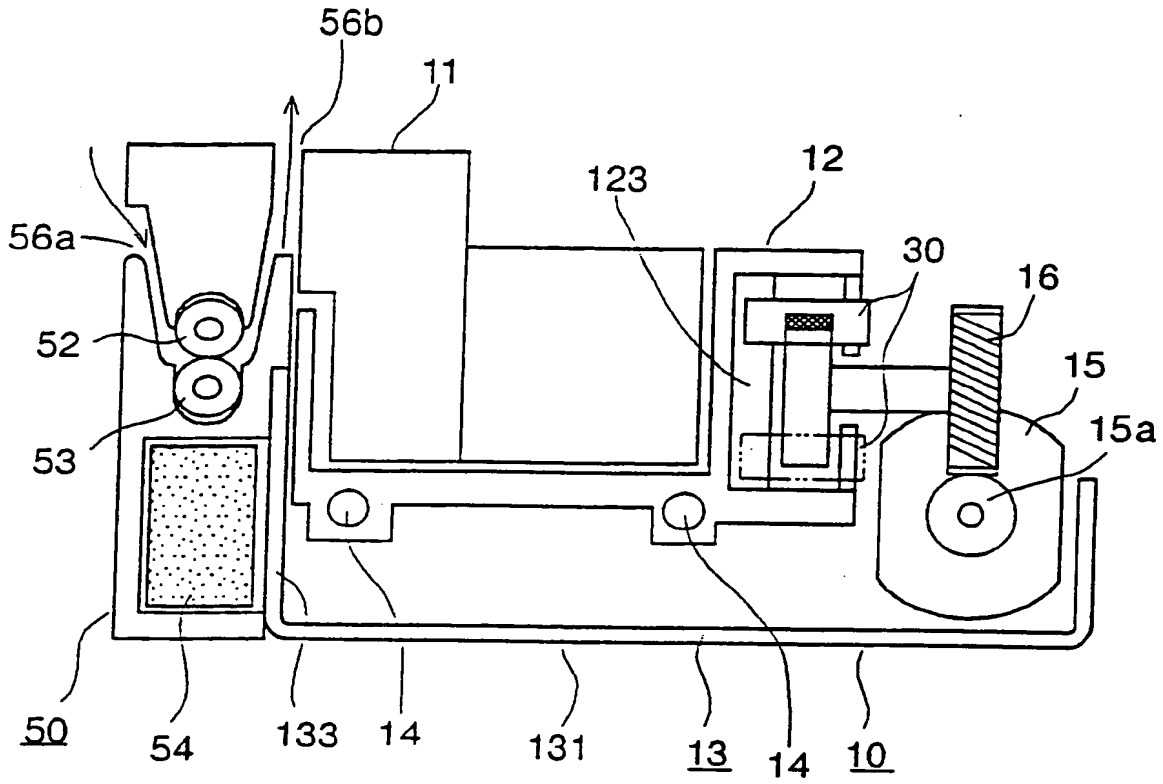


FIG. 3

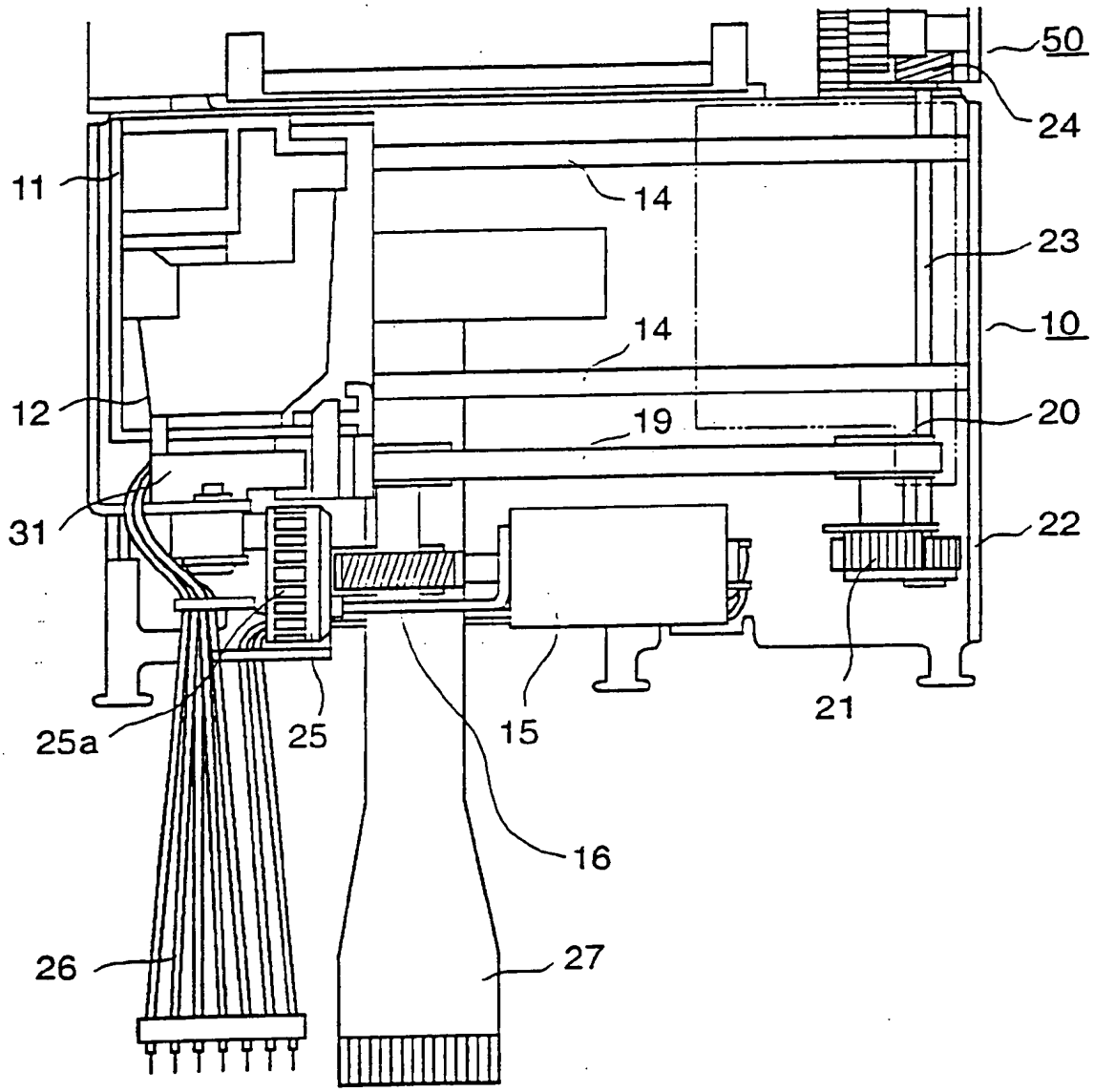
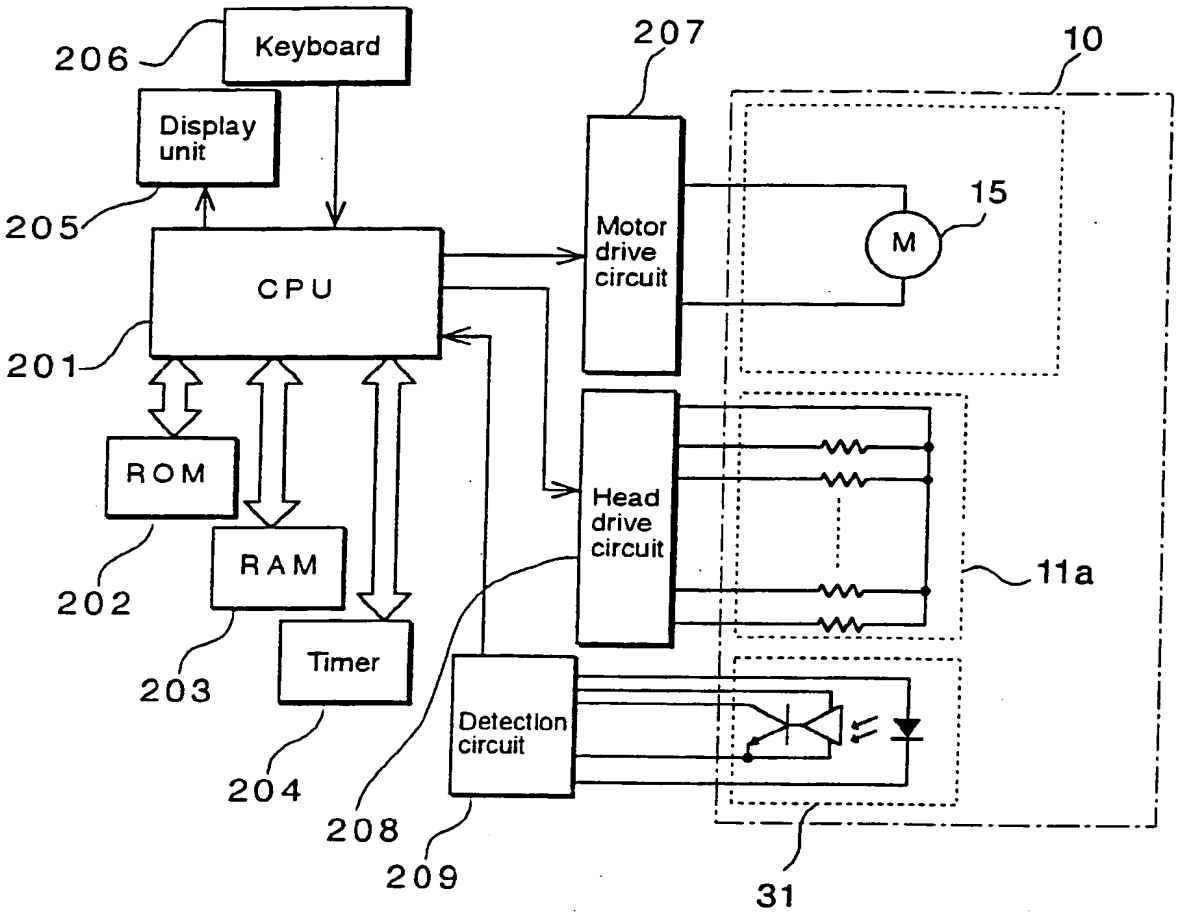


FIG. 4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205
CPU
201
ROM
202
RAM
203
Timer
204
207
Motor drive circuit
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M
10
Head drive circuit
11a
Detection circuit
208
209
31

FIG. 5

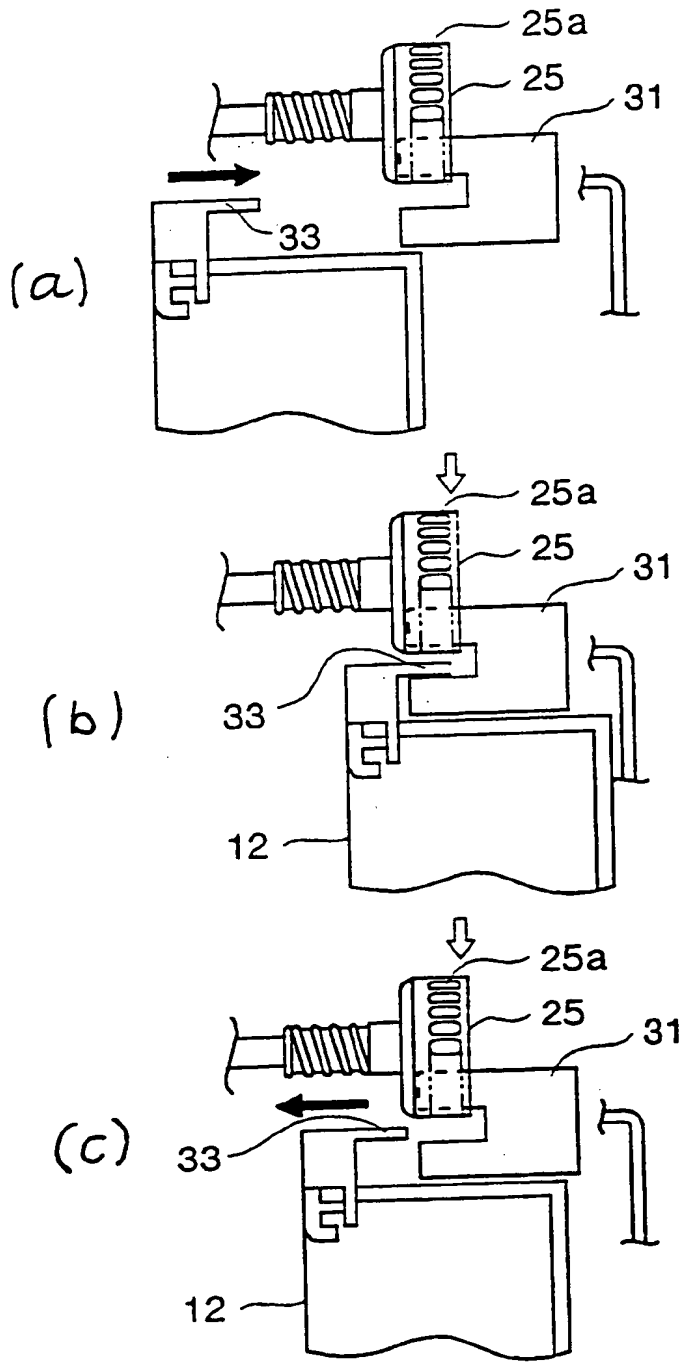
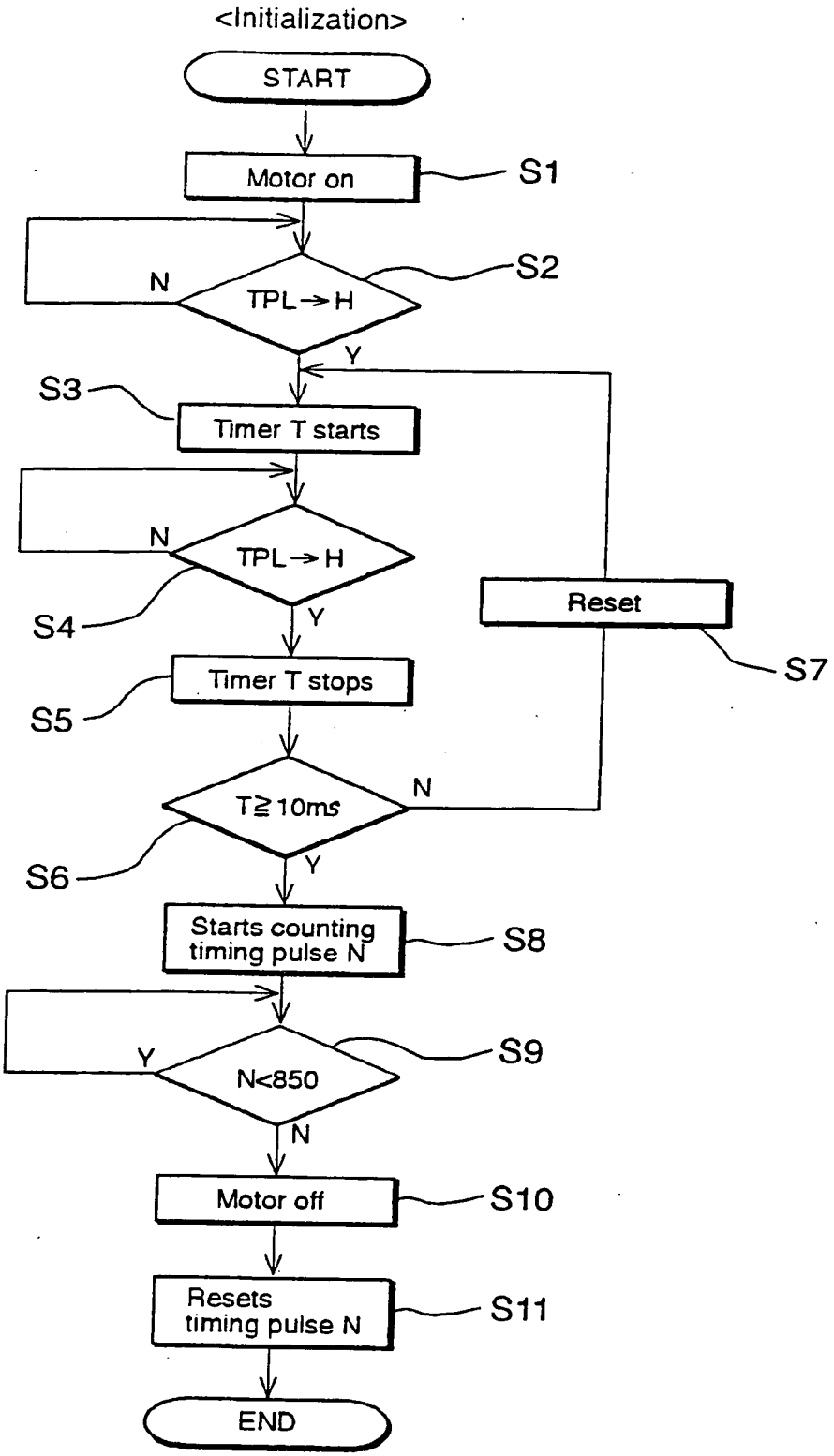


FIG. 6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START
Motor on
S1
N
TPL→H
S2
Y
S3
Timer T starts
N
TPL→H
S4
Y
Reset
S7
Timer T stops
S5
T≧10ms
N
S6
Y
Starts counting timing pulse N
S8
Y
N<850
S9
N
Motor off
S10
Resets timing pulse N
S11
END

FIG. 7

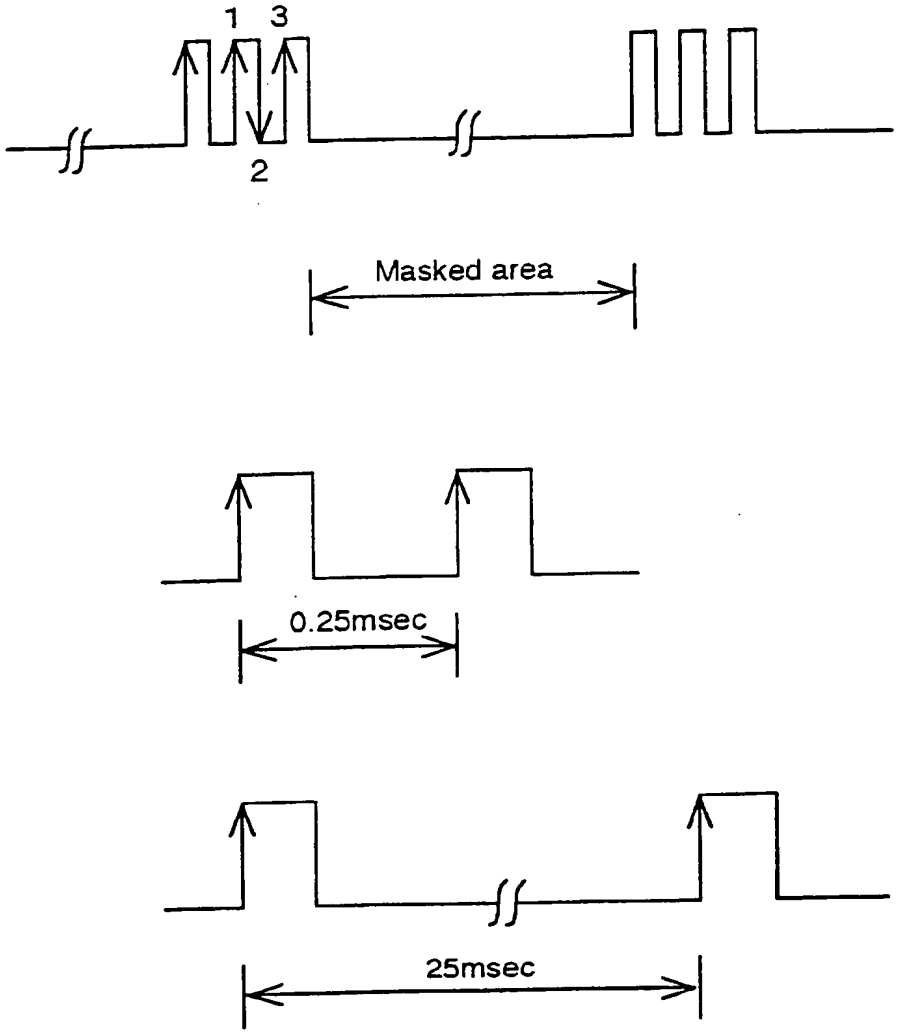

FIG. 8

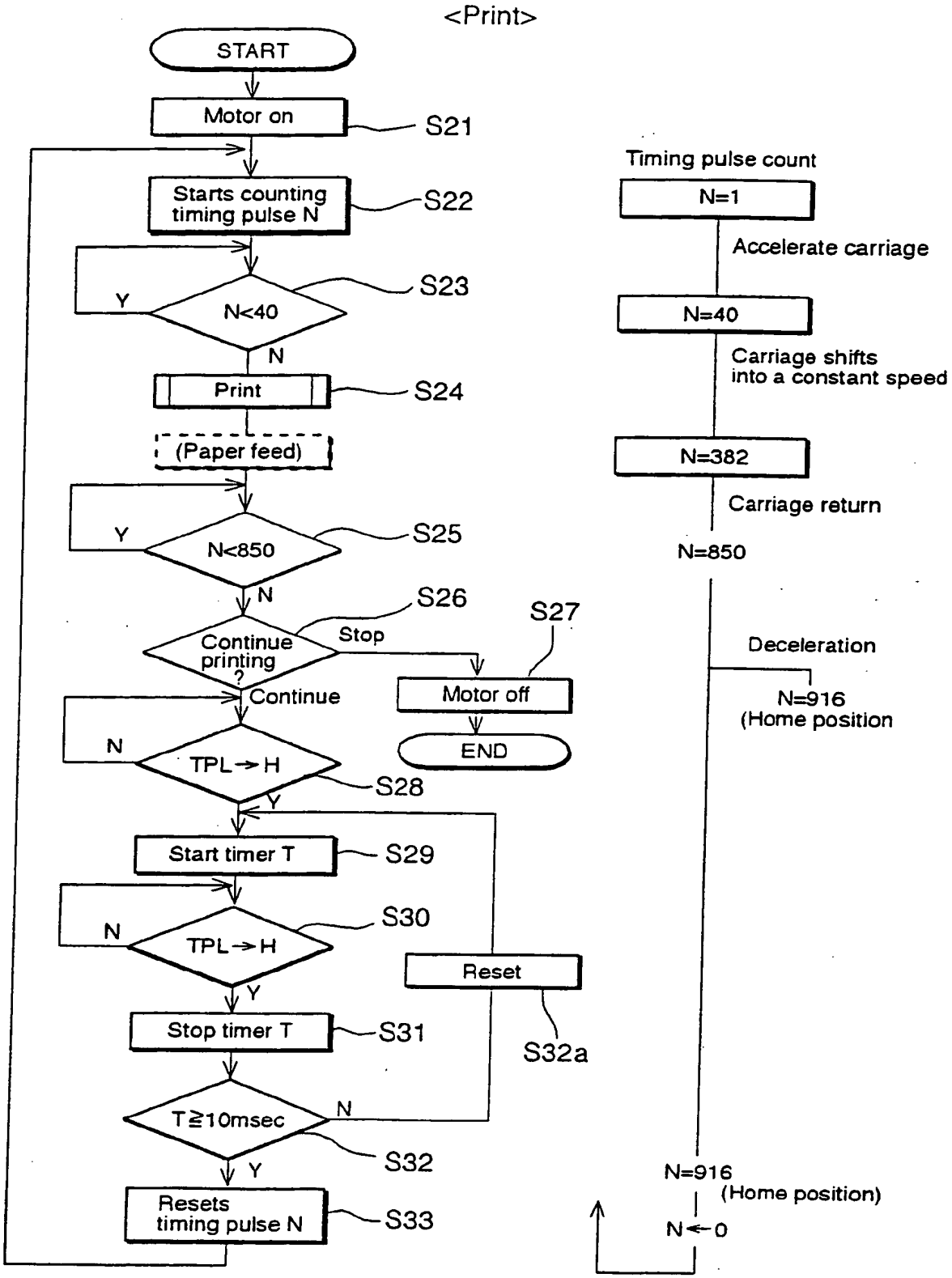
<Print>
START
Motor on
S21
Starts counting timing pulse N
S22
Y
N<40
S23
N
Print
S24
(Paper feed)
Y
N<850
S25
N
Continue printing ?
S26
Stop
S27
Motor off
END
Continue
N
TPL→H
S28
Y
Start timer T
S29
N
TPL→H
S30
Y
Stop timer T
S31
T≧10msec
N
S32
Y
Resets timing pulse N
S33
Reset
S32a
Timing pulse count
N=1
Accelerate carriage
N=40
Carriage shifts into a constant speed
N=382
Carriage return
N=850
Deceleration
N=916 (Home position
N=916 (Home position)
N←0

FIG. 9

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(54) Printer and method of controlling it

(57) A serial printer has a pulse generator (25, 25a, 31) for generating timing pulses in a number proportional to the movement of a carriage mounting the printer's recording head. The pulse generator comprises an encoder (25) and a detector (31) moved relative to each other as the carriage is moved. The detector is responsive to marks (25a) provided on the encoder (25) for generating the timing pulses. Blocking means (33) are provided to block the detector (31) when the carriage is at a predetermined position such that the detector cannot detects any marks of the encoder as long as the blocking condition is maintained. Signal processing means are provided to recognize the blocked condition of the detector and to output a home position detection signal in response to it. In this way the pulse generator also functions as a home position detector obviating use of a separate home position detector.

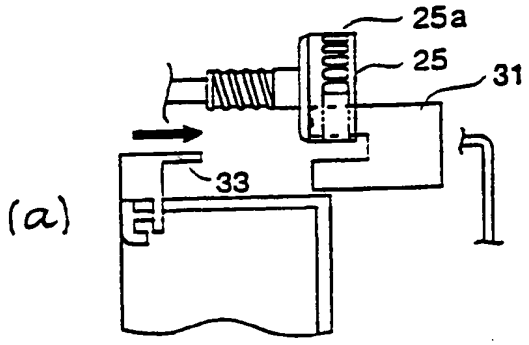

FIG. 6

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EUROPEAN SEARCH REPORT

Application Number
EP 94 12 0469

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-5 090 829 (J.W. LEE) * the whole document *	1-3	B41J19/18
A	EP-A-0 291 099 (BROTHER KOGYO K.K.) * the whole document *	1	
A	PATENT ABSTRACTS OF JAPAN vol. 15, no. 120 (M-1096), 25 March 1991 & JP-A-03 009866 (I. KENICHI), 17 January 1991, * abstract *	4-6	
A	PATENT ABSTRACTS OF JAPAN vol. 14, no. 256 (M-980) [4199] , 4 June 1990 & JP-A-02 072984 (K. SUGIYAMA), 13 March 1990, * abstract *	4-6	
A	US-A-4 264 220 (S.A. OKCUOGLU)		
A	US-A-3 891 077 (W. SAUERBRUNN)		TECHNICAL FIELDS SEARCHED (Int.Cl.6)
A	US-A-5 158 379 (M. MORIYA)		B41J

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	16 October 1996	Van den Meerschaut,G

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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CLAIMS INCURRING FEES

The present European patent application comprised at the time of filling more than ten claims

☐ All claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for all claims.

☐ Only part of the claims fees have been paid within the prescibed time limit. The present European search report has been drawn up for the first ten claims and those claims for which fees have been

namely claims:

☐ No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of the unity of the invention and relates to several inventions or groups of inventions, namely:

see sheet B

☒ All further search fees haven been paid within the fixed time limit. The present European search report has been drawn up for all claims

☐ Only part of the further claims fees have been paid within the prescibed time limit. The present European search report has been drawn up for for those parts of the European patent application which relate to the inventions in respects of which search fees have been paid,

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namely claims:

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EP 94 12 0469 -B-

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirement of unity of invention and relates to several inventions or groups of inventions, namely:

1. Claims 1-3: The home position detection means
2. Claims 4,5: The control method